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AUTHOR Jonassen, David H.
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ABSTRACT

Two methods of structuring textual material, information mapping and programmed instruction, were compared on the basis of their ability to facilitate recall and subsequent retrieval of information. Both methods produced very significant gain scores, although no differential effects occurred. Retrieval of information from the text, a task independent of recall behavior and based upon different textual search strategies, benefitted significantly from the structural characteristics of the mapping technique. A conceptual basis for the issue being studied was suggested: a comparison of systematically inserted adjunct questions and explicit content structuring for eliciting mathemagenic activities. A need for additional research to consider the level and type of learning and interactions with the characteristics of mapping and programming is indicated. A list of references is provided. (Author/RAO)

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RECALL AND RETRIEVAL FROM MAPPED AND PROGRAMMED TEXT

David H. Jonassen, Ed.D.
Assistant Professor
School of Education
University of North Carolina at Greensboro
Greensboro, North Carolina 27412

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Abstract

Two methods of structuring textual material, inormation mapping and programmed instruction, were compared on the basis of their ability to facilitate recall and subsequent retrieval of information. Both methods produced very significant gain scores, however no differential effects occurred. Retrieval of information from the text, a task independent of recall behavior and based upon different textual search strategies, benefitted significantly from the structural characteristics of the mapping technique. A conceptual basis for the issue being studied was suggested: a comparison of systematically inserted adjunct questions and explicit content structuring for eliciting mathemagenic activities. Suggestions of appropriate literatures such as structural linguistics are somewhat conjectural because of the absence of any research base for mapping.

Introduction

A reversionary trend toward print, textual media for instruction is based upon the increasing importance of cost effectiveness as a selection criterion. Audiovisual media, in varying degrees of sophistication, have failed to produce the panaceas predicted with their development. Coupled with the continuing preeminance of print (verbal mode) instructional media, the need to explore the potential of text for information transmission and retrieval has never been greater.

One of the most promising print methodologies, information mapping[1] (MAP), will be compared with another prominent method for structuring prose, programmed instruction (PI). This study constitutes a seminal investigation, aimed at documenting main effects (evaluative comparison) and suggesting some theoretical bases for considering these instructional methods. As such, it should raise more questions than it answers, however, this seems appropriate considering the embryonic state of information mapping research.

Programmed Instruction

Programming textual materials normally consists of limiting the size of information chunks, requiring overt responses to the information presented, providing feedback (reinforcement), and allowing for individual pacing. Evaluative research or programm instruction abounds, the reviews (Lange, 1972; Schramm, 1964) generally indicating a slight learning advantage and a more significant time savings for PI when compared with traditional instruction. In analyzing the contribu-

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[1] Information Mapping™ is a trademark of Information Resources, Inc.

tions of the aforementioned characteristics of PI, Hartley (1974) concluded that none were essential to the success of any program, that removing one or more of these techniques has little if any effect on the learning results.

The intention of this study is to identify a common basis for comparing media, not replicating research on programming attributes. The programmed version of text prepared for this study could alternatively be defined as the systematic insertion of adjunct questions (Rothkopf, 1972) into textual material, as multiple choice questions were consistently inserted after chunks of prose, with knowledge of results presented immediately. While the programmed material compared with mapping in this study includes all of the characteristics of programming cited above, it could easily be sumsumed by another rubric. The naming of the technique is not as important as the underlying cognitive processes.

The issue of importance is the degree to which consistent overt responding to textual material with subsequent feedback will evoke recall behavior. Several studies have supported the facilitative effect of inserted post-questions, especially for intentional learning, on immediate posttests (Frase, 1968; Rothkopf, 1972; Rothkopf & Bibiscos, 1967). Learning can be expected to improve as a function of the programming technique employed in this study.

Information Mapping

Information mapping is a technique for developing textual materials developed by Robert Horn almost a decade ago (Horn, Nicol, and Kleinman, 1969). It consists of a specific set of rules and procedures for classifying, organizing, and presenting information. The primary characteristics include chunking information into units and presenting it in labelled blocks, the marginal labelling providing an

intrinsic indexing system. With the presentation format remaining consistent, these information blocks are sequenced congruously with the nature of the information being presented into superordinate structures or maps (structure, procedure, process, fact, concept and principal types). The structural characteristics externally organize information, with hypothesized facilitation of information coding and retrieval.

As an instructional methodology, information mapping is only beginning to emerge. Used as format for presenting formal reports (Hartjen, 1977), it has been recommended as a valuable technique for instruction (Thiagaragan, 1977), industrial training (Horn, 1975), computer assisted instruction (Horn, Nicol, Roman, & Razar, 1971) and task analysis (Shroeder, 1975). Surprisingly little literature has chronicled its development as an important medium for industrial communication. Even less empirical analysis exists, although research is currently in progress, especially in England. The two most prominent studies failed to document any learning benefits from mapping when comapred with prose (Horn, Nicol, & Kleinman, 1969) or with computer assisted instruction (Geisert, 1970), however attitudes toward mapped texts were superior in both. However, neither study provides any theoretical or empirical support for the claims of its developer.

As a seminal effort, this study focused on the potential of some of the major characteristics of programmed and mapped texts for eliciting recall and as a medium for information retrieval. Conceptual foundations will be considered later.

Recall. Since no analysis or manipulation of mapping variables has been done, inferences or predictions about mapping characteristics must derive from other literatures, specifically that related to the semantic

structure of prose, an issue which has received considerable attention. Prose passages normally contain an implicit organizational structure of content. Recall of ideas becomes a function of the height in the content structure of a given idea, i.e., ideas high in the structure are better recalled (Meyer & McConkie, 1973). This engendered the concept of staging (Grimes, 1972), the dimension of prose structure that determines the prominence of ideas within prose. Clements (1976) found that prose segments at high staging levels were recalled better.

This type of research convinced Meyer (1975) that she could "signal" this structure to the learner by adding non-content signals ("There are two approaches. One is . . . ") that would emphasize aspects of the content or its structure. Improved recall resulted, however additional research is needed. This type of research sets a precedent for the extrinsic reporting of prose structure, as occurs in information mapping, where types and levels of information are labelled allowing the learner to relate aspects of content together using the techniques of blocking and labelling.

The blocking of information produces the effect of associating linguistic elements together in a holistic fashion. Information enclosed in a block becomes a unit, permitting comparison of within-block semantic similarities to differences in elements presented in other blocks (Gropper, 1970). This chunking of information can also be reasonably expected to facilitate encoding of locative information about passages into memory. Christie and Just (1976) corroborated earlier results in concluding that individuals accurately remember the location of information in text. These incidental locators can act as spatial attributes of memory (Underwood, 1969) which function to discriminate one memory from another, thereby facilitating retrieval of the associated information from

memory. The extrinsic blocking of information can only be expected to strengthen these spatial cues, facilitating recall of information intext.

Predictions about labelling must be derived from the literature on headings. Functioning as advanced organizers, headings provide conceptual cues about the ensuing information in a passage, providing an "explicit structure which assists the reader in integrating the information as he reads" (Wright, 1977, p. 96). Recall has been facilitated by subsuming information under major subheadings (Dahl, 1973) or by presenting one line titles immediately prior to the passage (Dooling and Lachman, 1971). Wright (1977) recommended differentiating these headings from the body of the text, either spatially or typography, as is done in information mapping.

Retrieval. Since information mapping has been recommended as an effective tool, consideration of the information retrieval characteristics seem important. However, the literature related to information retrieval is concerned either with memory processes or automated retrieval systems modelled after the former. Techniques for facilitating the retrieval of information from text material, such as those suggested by information mapping (table of contents, predictable textual format, consistent typography, marginal labels, and local indexing) operate in an atheoretical context, so that any successes forthcoming must be explained by other literature. Searching is generally agreed to be aided by section headings presented in the text and in a corresponding table of contents (Wright, 1977), but how these and other techniques work is uncertain.

Textual searching becomes a matter of associating locative information (spatial cues) stored in memory with their referent as it appears in a passage. Information mapping provides explicit cues (labels) which

may be encoded as locative information in memory. Information retrieval requires associating only the locative cue with the label, thereby reducing memory load. At the very least, labels may be used as a convenient tag for searching text.

Some implications of blocking also seem obvious. Christie and Just (1976) hypothesized that "locative information could provide an index to the spatial distribution of information in the passage" (p. 706). Since retrieval of information from a passage, measured by eye fixations, was more efficient for organized passages, explicitly chunking information into units can only be inferred to provide stronger or more easily differentiable locative cues. Visual scanning should be accomplished more easily, thereby increasing textual retrieval capabilities.

Finally, the consistent format for sequencing information suggests a search strategy for locating information. Search rules are suggested by the materials because the learner knows conceptually where a particular attribute is located in relation to other material. This explicit sequencing should provide the basis for a consistent search procedure.

Method

Participants

Forty-one seniors and graduate students enrolled in two sections of an introductory media course were assigned to treatment. Attrition accounted for unequal N's (MAP = 22, PI = 19). Verbal ability level and subject background were assumed equivalent as no significant differences between groups in pretest performance occurred.

Procedures

All subjects were pretested and assigned to treatment. One week following the pretest, the self-study materials were presented to the

participants, who were allowed to complete them at their own pace. Immediately following completion of the text, each individual turned in the material and requested the exam (same as pretest), a 45-item, four-option multiple choice exam. Test items were extracted verbatim from the text. The tests, in addition to the texts, were reviewed for content validity by three subject matter experts. Reliability of the instrument was established by the Spearman-Brown split-half technique ($r = .83$).

Two weeks following treatment all subjects were administered the retrieval examination, an open-book task consisting of 41 sentence-completion questions that required reference to the textual material. A total of one hour was allowed for this exam for all participants. To insure retrieval from the text occurred rather than recall behavior, subjects were required to indicate the page number in the text that contained the answer.

A pretest - posttest design was employed in this study, with each treatment group serving as the control for the other group. In subsequent studies a control group (narrative prose test) will be employed. The delayed test was not intended to assess the same dimension of cognitive functioning as the recall (pretest-posttest) task, so those results were analyzed separately.

Results

A 2x2 analysis of variance (ANOVA) (test X method) was calculated for the data presented in Table 1. A significant main effect for treatment, F (1, 39) - 340.92, p <.001, was experienced by both groups, though

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Insert Table 1 about here

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no differential effect of treatment (group X test) occurred, as gain scores were fairly equivalent. Since no significant differences in pretest scores and posttest scores occurred, it can be concluded that both the MAP treatment and the PI treatment produced similar amounts of learning.

An F test for homogeneity of variance in the retrieval test scores indicated equivalence (F (21, 18) = 1.11, $p > .05$) so that a t test for independent means was conducted. A significant difference (t (21, 18) = 4.14, $p < .001$) between the scores of the treatment groups occurred, indicating that the MAP group performed substantially better than the programmed group on the retrieval task. It is obvious from the data that the retrieval task was different and independent from the earlier recall task. The relationship between posttest scores and retrieval scores was extremely low and insignificant (r = .15) and the variances for the retrieval task were substantially higher. This indicates that this task was not facilitated by earlier learning (recall). In an attempt to control for the effects of prior learning, an analysis of covariance was conducted, indicating that recall (prior learning) was not a significant covariate with retrieval, confirming the independent nature of the retrieval task and the superiority of the MAP treatment for facilitating it.

Discussion

Recall

Significant learning (recall) resulted from both the PI and MAP techniques, indicating that for initial learning, both are adequate as presentational media. Without a control group treatment (narrative prose), the extent of recall facilitation resulting from their respective

characteristics remains undocumented. It can only be concluded they produce equivalent amounts of learning. While initially disappointing, this equivalence in resultant learning provides a meaningful empirical context for suggesting a conceptual basis for their comparison.

The advantages of mapping are obviously structural, based on the premise that by breaking down information into small chunks and explicitly structuring the context, learning will be improved. Frase (1969) provides empirical support concluding that recall is enhanced by informing the reader of the structure of a passage prior to reading the material. By clearly defining the function of these information chunks and their conceptual relationship to other chunks, you are explicitly organizing material for memory. Like advanced organizers (Ausubel, 1968), mapping provides conceptual tags which function as an explicit "ideational scaffolding" for assimilating information. McConkie (1978) suggests that a complete understanding of the effects of prose structure on recall probably necessitates looking at some structural linguistic literature (Grimes, 1972; Meyer, 1975). For purposes of this discussion, suffice it to say that the important intrinsic characteristic of mapping is the structuring of content in textual passages. A meaningful context for comparing mapping and programming is the mathemagenic hypothesis.

The concept of mathemagenic activities (Rothkopf, 1970) should be familiar to most researchers. Meaningful prose learning has been consistently enhanced by the elicitation of mathemagenic activities in the learner, the covert mediational behaviors that produce learning, that determine "the nature of the effective stimuli in experimental or instructional situations" (Rothkopf, 1970, p. 326, emphasis his). Several techniques have been reviewed as capable of manipulating learners cognitive activities during acquisition, such as advance organizers,

response modes (underlining, notetaking), objectives, and inserted questions (Faw & Waller, 1976). This list should include explicit content structuring that is provided by information mapping procedures. It can be tentatively concluded that this technique directly affects Class III mathemagenic activities, those concerned with visual scanning, translation into meaningful constructs, and internal cognitive processing (discrimination, differentiation) of prose (Rothkopf, 1970). It seems obvious that ordering and prearranging text will affect reading as do the other techniques suggested earlier. So the issue actually addressed in this study concerns the type and extent of mathemagenic activities elicited by consistently inserted questions vis a vis explicit content structuring. At the processing stage of Class III behavior, some form of organization of material inevitably occurs that will facilitate memory coding. The structuring implicit in the mapping technique could be hypothesized to supplant these mathemagenic activities (Ausburn & Ausburn, 1977). At any rate, it seems logical that mathemagenic activity is a meaningful context for comparing and analyzing the effects of these instructional methods on learning (recall).

Retrieval

The structural characteristics of mapping provide a clear advantage for retrieving information from textual materials. Some combination of the marginal labels, consistent format, and information blocking significantly facilitated the visual search procedure. In order to understand the contributions of each, these variables will have to be manipulated. It should be obvious from the previous discussion of mathemagenic activities that an alternative construct is needed to adequately deal with the retrieval process, since learning is not the issue of concern. Rather we need to be concerned with those textual characteristics that will

maximally facilitate the search for specific information. A review of the reference and indexing literature should be combined with an analysis of automated information retrieval systems filtered through a visual information processing perspective, such as that suggested by Clark, Carpenter, and Just (1973). The retrieval issue is important and distinctive enough to be divorced from consideration of the learning potential of mapping, since different assumptions and analyses will be required for its proper consideration.

Summary

The potential of information mapping as an instructional technique seems obvious, however the virtual absence of any research base relegates mapping to the "potential" status. While this study was methodologically deficient (absence of control group, study time factor, prior experience, or concern with relevant learner aptitudes), it was intended only to globally address the issues and assumptions of mapping. The need for additional research to consider the level and type of learning and interactions with the characteristics of mapping and programming is unlimited. Additional research can be expected to clarify the usable parameters of both methods of instruction as well as shedding another glimmer of light on how learning occurs.

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Table 1

Means and Deviations for Treatment Groups by Test

		Map Group	Programmed Instruction Group
Pretest (Recall)	$\bar{X}$	28.18	27.84
	SD	3.51	5.37
Posttest (Recall)	$\bar{X}$	38.86	37.53
	SD	2.87	3.37
Retrieval Test	$\bar{X}$	33.90	22.94
	SD	8.16	7.76
N		22	19